Appendix H
Field Analytical Technologies

H.1 Scope of Application/Background

H.1.1 Field analytical technologies are rapidly evolving. Growth is apparent in both the number and types of techniques available, as well as in improvements in selectivity and sensitivity. These and other advances have increased the viability and application of field analytical technologies to the support of Hazardous, Toxic, and Radioactive Waste (HTRW) project execution. However, the use of field analytical technologies is too often overlooked or disregarded due to a general misconception by regulators, project personnel, and other stakeholders regarding the quality or comparability of the resulting data, and the perceived difficulty in the planning and execution of these techniques. Additionally, the project planning team members may be unfamiliar with the types of field analytical technologies and services available. Other limitations include a lack of reliable performance data for a particular environmental matrices, unknown performance under adverse field conditions, and incomplete or unreliable cost data to support an evaluation of the field analysis. This appendix will identify project-specific information needed to evaluate field analytical technologies application (Section H.2); provide general guidance for selecting appropriate technologies (Sections H.3 and H.4); provide general guidance for implementation and oversight of field analytical technologies (Sections H.5 and H.6); and identify sources for gathering specific information on field analytical technologies available and generating case studies(Section H.7).

H.1.2 Field analytical technologies are used to monitor unstable or volatile parameters (e.g., pH, redox potential, dissolved oxygen, temperature, etc.); provide health and safety information on highly contaminated areas that should be avoided or require special considerations; perform general site reconnaissance to identify hot spots or areas requiring further investigation; provide rapid or real-time data to focus the selection of samples for definitive or confirmatory analyses, or to optimize sample locations chosen for a more efficient sampling/analytical strategy; monitor remedial actions/treated waste streams to provide a timely assessment of its effectiveness; or provide an increased sample density onsite for statistical treatment, or to more thoroughly define nature and extent of contamination in an area/matrix, etc. Many times, field analytical technologies are used to support expedited site characterizations or adaptive sampling and analysis plans execution. In this way the field measurements are used in conjunction with an established decision logic to identify appropriate contingencies or actions in the field. In addition, the advent and promoted use of performance-based measurement systems and performance-based methods encourage the use of field analytical technologies as the primary analytical tool supporting project decisions, refining the project conceptual site model, etc. Field analytical technologies are easily integrated into a more cost-effective data collection option for site characterization and environmental restoration monitoring.

H.1.3 Field analytical technologies are routinely categorized as either field screening or field analyses. The specific application of either term depends on the amount of quantifiable error, level of method quality control (QC), and selectivity of the technology in question. Distinction between the terms may also be dependent on the efficiency of the preparatory procedures used to isolate analyte(s) of interest. Application of both types of field analytical technologies has utility in the U.S. Army Corps of Engineers HTRW program and will depend on the specific data need. Instrumentation used to support the generation of field screening or field analyses data may be grouped in one of the following three categories:

- Hand-held or portable: no external power source required/able to be used directly or with limited setup/typically provides qualitative or semiquantitative data

- Transportable or field portable: external power source required/able to be used with nominal facility (i.e.,van)/typically provides semiquantitative to quantitative data

- Mobile laboratory: external power source required/must be used within controlled environment and/or facility/can provide quantitative (definitive) data similar to a fixed laboratory, depending on the specific analytical *(preparatory/determinative)* methods employed

H.1.4 Regardless of whether field screening or field analyses techniques are employed, a certain percentage of the data may have to be confirmed by definitive data. The definitive data may be generated onsite at a mobile lab or at an offsite laboratory. The appropriate percentage of confirmatory analyses should be determined based on the quality of the field data generated and its intended use.

H.2 Project Data Needs and Information

H.2.1 EM 200-1-2 provides guidance on a systematic planning process to determine overall site goals, project objectives, and project data needs that are used to define the data collection program. It endorses the generation of an appropriate type and quality of data based on its intended purpose. If done properly, the project planning process may determine that application of a field analytical technology is as good, or better than fixed laboratory analyses. In order to benefit from field analytical technologies, project team members must understand the flexibility and advantages that onsite data provide in tailoring a sampling and analysis program during execution. Additionally, the technical planning team must know where to obtain information on the types of field analytical technologies available. To determine the viability of field analytical technologies application, the technical planning team should utilize the guidance established in EM 200-1-2, gleaning the following project information, and evaluate its potential utility. After an assessment of project information, the technical planning team can decide whether application of field analytical technologies is feasible and may benefit the project.

H.2.2 During EM 200-1-2 Phase One, information is gathered on prior site use, site-related contaminants, and their expected range of concentrations. Note any site constraints or features that may impact the field technologies performance. For instance, knowledge of the site location, temporal/seasonal conditions, and general site topography may define whether site constraints exist due to isolation of the site, short working seasons, or if the terrain imposes additional demands or hazards. Specifics on depth to ground water, soil type, soil moisture content, or soil organic content can provide invaluable information when evaluating applicability of a particular field analytical technique or when comparing multiple techniques.

H.2.3 During EM 200-1-2 Phase Two, project personnel articulate the appropriate project data needs and their intended purpose. Most importantly, the data user must define any applicable action or decision levels and any uncertainty, performance, or acceptance limits associated with the use of this decision level. This information is used during Phase Three by the sampling and analysis data implementors to determine the project contaminants of concern or chemical parameters to be measured. Key issues to focus on, include estimating the number of samples needed to support the data use and defining those contaminants to be monitored. The number of samples anticipated should be sufficient so that the offsite analytical costs are comparable to or greater than the costs of using a field analytical technology. For depending on the capital investment (rental or purchase of instrumentation), facility requirements, consumables, and labor costs of onsite personnel, a minimum number (e.g., 50 to 200) of samples may be necessary to support the use of the field analytical technology. When determining the contaminants to monitor, consideration should be given to the most mobile contaminants, such as those most likely to reach ground water, or are the best indicators of migration potential. Other criteria include contaminants that pose the greatest risk or may directly impact remedy selection. Evaluation of the physical and chemical characteristics (e.g., water solubility, octanol/water coefficient (Kow), etc.) of the contaminants help to assess their fate and transport potential. Finally, if there are a number of contaminants present that may be monitored, selection should be based on the analyte that is most reliably detected by the available field analytical technologies. The above information is used to determine the project indicator compounds, and where, and from what type of media to collect the samples.

H.2.4 Preliminary project measurement quality objectives (MQOs) should be formulated to define requirements with which to evaluate applicability of field analytical technologies available. Topics include defining selectivity requirements. For instance, whether an individual target analyte(s) or a chemical compound class require monitoring. Define sensitivity (detection limit) requirements as clearly as possible, for this is typically a critical parameter depending on data use and contaminant concentrations found onsite. Any uncertainty requirements established by the data user support the specification of preliminary MQOs for precision and bias of the field analytical technologies, and to estimate the percentage of confirmatory/definitive data necessary.

H.3 Identification of Applicable Field Analytical Technologies

H.3.1 Using the sources outlined in Section H.7, knowledge of type of media to be sampled, and contaminants to be measured, identify potential field analytical technologies to use. It is important to involve technical personnel familiar with the basis of measurement for the field analytical technology (i.e., what chemical and/or physical property of the contaminant is being measured) and the factors controlling performance, to optimize performance to field matrices and understand data comparability issues. The field analytical technology may be based on existing laboratory instrumentation, modifications (e.g., microinstrumentation) to existing instrumentation, or a new technology. Use of unproven, emerging technologies may require the use of more extensive pilot studies, increased QC measures, and/or interim milestones at project initiation, to verify the viability of the field method and reinforce confidence in its data. Identify technologies possessing capabilities that, at a minimum, meet the stated project MQOs for selectivity, sensitivity, bias and precision identified from Section H.2.4. Care should be taken when interpreting vendor claims for selectivity, sensitivity, bias, and precision, for these may be based on a clean or well-homogenized matrix. Suggest using the vendor information for estimating purposes only. If any of the MQOs or performance objectives are critical to decision-making, verification of these parameters using project-specific matrix(ces) is encouraged. Typically, vendors will perform preliminary studies to verify sensitivity, establish appropriate calibration standards, or verify precision and bias at a project action or decision level with the use of project-specific matrix(ces) at nominal cost. Next gather information identified in Sections H.3.2 - H.3.4 for applicable field analytical technologies to evaluate them for potential selection or exclusion.

H.3.2 Review performance capabilities of applicable field analytical technologies. Identify media applicable to the field analytical technology or method, the calibration range, and false positive (FP) / false negative (FN) rates. If information is available, verify the spike concentrations at which the FP and FN studies were performed, assessing their relevance to project action or decision levels. The FP/FN values claimed should also be interpreted as approximate values, and project-specific FP/FN values should be determined in conjunction with execution as outlined in Section H.5.

H.3.3 Review operational characteristics of applicable field analytical technologies. These include items such as sample analysis time (estimated samples/day), capital investment necessary, consumables costs per test/number of tests, estimated labor costs, facility needs and consumable storage requirements, operator experience requirements, any training courses or certification requirements, and the portability and reliability (durability, ruggedness) of instrumentation.

H.3.4 Review limitations and interferences of applicable field analytical technologies. This includes unsuitable physical conditions and any known chemical interferences or cross reactivities.

H.4 Field Analytical Technologies Selection

Once a listing of applicable field analytical technologies are defined, the strengths and weaknesses of each are compared to support selection of the technology to employ. Review each field analytical technologies performance capabilities, operational characteristics, and limitations as defined in Sections H.3.2, H.3.3, and H.3.4 against site features, project constraints, and any project DQOs/MQOs to identify those to retain or eliminate. Additional issues to address include the suitability of the technology to site physical conditions, the commercial availability (rental versus purchase) of the equipment, the maturity of the technology (new/emerging, accepted/proven), and whether it has been applied to a variety of site conditions. Final choice of the field analytical technology to employ (all other features being equal/similar) will be defined by differences in cost. Tradeoffs for performance, quality, and cost must be reconciled among data users. Cost comparisons become more involved when complex field analyses (e.g., mobile laboratory) are being implemented. In these cases, suggest cost comparisons estimate total costs, including capital investment, facility, consumables, and labor costs compared with the cost of the remobilization of another (phased) project execution.

H.5 Field Analytical Technologies Implementation

H.5.1 Implementation of any field analytical technology requires effective upfront project planning. Decisions must be made about the extent to which to apply the following procedures. While many of the items should be considered mandatory. Others will depend on project constraints, the critical nature of the field data's use, the maturity of the field analytical technique, and the similarity or correlation between the field technique and the definitive/confirmatory analysis whether to implement them.

H.5.2 Define the appropriate field screening/analytical methods to be used. If applicable, this shall encompass both the preparatory and determinative procedures and any modifications employed. Standard operating procedures (SOPs) must be generated for review/approval by appropriate project personnel and stakeholders in conjunction with the SAP. Refer to Section 4.4.2 of Chapter 4 for potential input into the format and contents of the field analytical SOPs. While the majority of SOP sections apply to both field screening and field analytical methods, the level of rigor and mandatory frequency for these subjects (i.e., calibration, quality assurance (QA)/QC procedures, corrective actions) may be less than those prescribed within the associated definitive data methodologies. These issues should be considered negotiable and should be set at a level that supports the intended use of the data and minimizes the risk of making a wrong decision. Any project-specific action levels (concentrations) or critical decision levels should be established at midcalibration range, if possible. In addition, consider periodic verification of this level to evaluate recovery ranges observed.

H.5.3 Determine the field analytical technology's application to and performance within a project-specific matrix by implementing any or all of the following procedures. If working directly with a manufacturer or vendor, submission of project samples to the vendor may be an option to calibrate field instrumentation (i.e, X-ray fluorescence), evaluate sensitivity, bias, or precision ranges. Pilot studies are another mechanism to allow the verification of a field analytical technology to project matrices with less risk or cost than full project mobilization. If neither option is utilized, recommend, at a minimum, that an interim milestone be established to review data generated and determine the viability of the technique prior to full-scale project execution. During these interim measures, suggest implementation of the following. Determine matrix-specific detection and quantitation limits to assess sensitivity of technique. Refer to section I.3.3.7

of Appendix I for procedures to evaluate sensitivity. Verify that the sensitivity achieved is at least one-half of any project action or decision levels. If this is not attainable, suggest verifying this level with a low-level check or other sample as noted in Section H.5.2. When abbreviated or modified preparatory procedures are conducted, suggest a study be performed to verify extraction efficiency at project initiation to optimize extraction times to the contaminant and matrix. Refer to Jenkins et al. (1996b) for additional information on this subject. Employ a high percentage (75-100 percent) of redundant definitive analyses initially to establish a correlation between the field analytical and definitive measurement techniques. This preliminary correlation (or conversion factor) between field and definitive results is used to ensure usability of the field analytical technology and its data. Define the minimum amount of data to establish this correlation. If there is a significant difference between the field analytical and definitive data, apply a conversion factor to the project action or decision levels to establish an appropriate field decision level.

H.5.4 Define appropriate QA elements to apply for proper chemical data quality management on the project. Refer to EM 200-1-6 for additional information on QA elements that may be employed. For instance, mobile laboratories may be subject to validation procedures or onsite inspection; single- or double-blind PE samples may be submitted to verify accurate determination of appropriate target analytes; field QC samples may be taken (blanks, replicates, matrix spikes, etc.) to monitor sampling, sample handling practices, and field analytical procedures. As noted in Section H.5.1, the frequency of implementation should be based on the intended use of the data.

H.5.5 Define the percentage of redundant, confirmatory/definitive analyses to employ throughout the remainder of the project to evaluate the initial/current correlation is accurate and representative of the data sets. Definitive analyses may be performed onsite or offsite. Suggest varying the samples submitted for definitive analyses between collocated grab samples, homogenized replicate samples, or portions of the original sample/extract/digestate to assess various sources of sampling and analytical error. Suggest the samples sent for definitive analysis also encompass a variety of concentrations, as determined by the field results. Percentages may be applied as noted in Table H-1 or revised based on project size or DQOs. Alternatively, application may be based on whether the field results are above/below a project action level alone. Suggest a minimum of three above and three below the action level (or nondetect) be sent for redundant definitive analysis.

Table H-1
Recommended Percentage of Redundant Analyses for Confirmation Sample Analyses

Field Analytical Results (FAR) Relationship to Project Action Levels (AL) / Detection Limit (DL)	Recommended Percentage of Redundant Analyses
DL < AL < FAR	5 - 10% (allows FP assessment)
DL < FAR < AL	10 - 20%
FAR < DL < AL	10% (allows FN assessment)

H.5.6 Define appropriate field data review requirements, data reporting requirements, records archival and retention, and client notification requirements.

H.5.7 Employ data verification techniques to assess the comparability of the field and definitive data, and the useability of the field analytical data to support its intended use or other purposes. Use regression analysis or other statistical technique to compare the field analytical data to the definitive data, especially around the project action or decision levels. Results should be reviewed in light of the following considerations: sample heterogeneity, differences in protocols for the sample preparation or analysis. Determine the FP and FN rates for the field analytical technology (as compared to definitive results) and any impact this may have on the data.

H.6 Field Analytical Technologies Oversight

H.6.1 Conduct project oversight as described in Instruction G-1 of Appendix G. This should include a preliminary site visit and inspection during the pilot study or at the inception of the project to verify the following, at a minimum:

- All personnel have clear understanding of the contingency/corrective actions/notifications scenarios which apply based on field results, and its impact on field decision making.

- Sample handling procedures and field instrumentation use are in accordance with manufacturer's guidelines and approved SOPs.

- Field data reporting frequency and content requirements are understood and in place.

- Samples sent for definitive analysis are in accordance with logic prescribed in the Sampling Analysis Plan.

C QC results are compliant with project MQOs.

- Field data review is complete, accurate, and documented.

Additional field inspections should be conducted as needed to monitor ongoing field operations and project progress.

H.6.2 The project report should be generated to compile and discuss the field analytical results and their usability to support project decisions. Suggest this information be presented to the regulators, community, and customer to enhance communication and understanding of site data. Include data comparisons performed in light of the sample heterogeneity and differences in protocols noted in H.5.2. When the correlation coefficient (r) > 0.90, the field analytical data may be considered definitive, and may be used to support compliance, no-further-action alternative, and risk assessments. Lesser correlations may still provide quantitative or qualitative support for data needs, depending on the use of the data and consistency of the correlation. Finally, suggest that the U.S. Environmental Protection Agency (USEPA) guidance identified in Section H.7.4 be used to develop a project case study for the continued education and support of field analytical technologies and their use.

H.7 Information Sources for Field Analytical Technologies

H.7.1 Field analytical technologies encompass a wide range of technologies and instrument types. In general, the majority of techniques may be divided into the following categories: geophysical, inorganic, organic, unexploded ordnance/explosives, radiochemical, and health and safety. However, each source should be reviewed to identify the categories that may be queried. Due to the diverse nature and vast number of field analytical technologies available for detecting environmental contamination, guidance on key sources for retrieval of information is provided.

H.7.2 The following websites provide sources of information for the types of field analytical technologies available for a particular contaminant and media, and/or information on vendor sources for commercial availability of the field instruments or analytical techniques.

- **FRTR** (**F**ederal **R**emediation **T**echnologies **R**oundtable)
  http://www.frtr.gov/
  This website maintains a Sampling and Analysis Matrix that provides comparative screening information for several sampling and analytical technologies. The matrix is intended to inform project personnel about the variety of technologies that are commercially available, providing a general comparison among them. Additional information is provided for each technology, including a general description, identifying applicable media, analytes/chemical parameter, selectivity, relative level of quantitation, detection limits, turnaround time, limitations, susceptibility to interference, status of technology (i.e., commercial availability), any certification/verification the technology maintains, and relative costs. The equivalent publication released at the initiation of the website is EPA/542/B-98/002, Field Sampling and Analysis Technologies Matrix and Reference Guide, March 1998.

- **FATE** (**F**ield **A**nalytic **T**echnologies **E**ncyclopedia)
  http://www.ttclients.com/encyclopedia/
  This website is intended to provide information about technologies that can be used in the field to characterize contaminated soil and ground water, monitor the progress of remedial efforts, and in some cases, and for confirmation sampling and analysis for site close out.

- EPA **REACH IT** (**RE**mediation **A**nd **Ch**aracterization **I**nnovative **T**echnologies)
  http://www.epareachit.com/
  This website replaces the VISITT, VendorFACTS, and ITT Databases. It provides information on the site characterization and monitoring options available. Information is included to identify the capabilities of vendor-specific instrumentation and technologies. Information is included on the technology description, applicability to various media, performance capabilities, and cost.

- DOE **PAM** (**P**referred **A**lternatives **M**atrix)
  http://www.em.doe.gov/define/
  This website provides a matrix to identify proven, available technologies and rank them on the basis of performance, risk of technology failure, and cost. The PAMs provide a tool for field personnel to focus remedy selection and expedite preferred alternatives implementation to allow preselection of effective, low- cost alternatives for monitoring of site contaminants.

- DOE **CMST-CP** (**C**haracterization, **M**onitoring & **S**ensor Technology**-C**ross Cutting **P**rogram) Vendor Database
  http://www.cmst.org/vendor/
  This website provides information for the chemical and physical property measurements of environmental samples. The CMST-CP maintains this vendor database as a focal point for environmental measurement technologies. The CMST Vendor Database matches user's measurements needs with available products.

H.7.3 The following websites provide a verification and evaluation assessment of several technologies. They represent an unbiased assessment of the technologies, normally performed by representatives of EPA or their contractors.

- EPA **ETV** (**E**nvironmental **T**echnology **V**erification) Program
  http://www.epa.gov/etv/
  This website provides credible environmental technology performance data for a variety of field analytical technologies resulting from an evaluation performed by independent third parties under the auspices of EPA. To date, ETV has generated several Verification Statements and Reports for several vendors' products for the following field analytical technologies: X-ray fluorescence, polychlorinated biphenyl (PCB) screening technologies (i.e., EPA/600/R-98/113, Immunoassay Kit: Strategic Diagnostics, Inc., EnviroGard PCB Test Kit), portable gas chromatography/mass spectrometry (GC/MS), soil gas sampling/analyses techniques, and SCAPS (site characterization and analysis penetrometer system). Future plans are to evaluate explosive screening tools.

- Cal/EPA California Environmental Technology Certification Program
  http://www.calepa.ca.gov/CalCert/
  Cal/EPA's certification program is a voluntary program that provides participating technology developers, manufacturers, and vendors an independent evaluation of the performance of new and mature environmental technologies. Performance claims made by the manufacturers are evaluated, and where necessary, additional testing is conducted to verify claims. The Web site provides access to the certification reports. Certifications may provide estimates of performance in areas such as efficacy and efficiency for specified uses, matrices, and chemicals; accuracy, precision, and detection limits for measurement of specified constituents; and other performance criteria. Currently, Cal/EPA has evaluated several monitoring technologies that are quicker and less expensive for detecting and measuring various contaminants (including BTEX (benzene, toluene, ethylbenzene, and xylenes), mercury, PCB, PCP (pentachlorophenol), PAHs (polynuclear aromatic hydrocarbons), petroleum hydrocarbons, TNT, and RDX) in contaminated soil and/or groundwater. Additional evaluations include accelerated solvent extraction (ASE) instrumentation, insitu subsurface field screening method for petroleum, oil, and lubricants that contain polynuclear aromatic compounds using laser-induced fluorescence (SCAPS-LIF), and a continuous on-line hydrocarbon monitor for waters.

- EPA **SITE** (**S**uperfund **I**nnovative **T**echnology **E**valuation) Reports
  http://www.epa.gov/ORD/SITE/index.html
  This website provides information on a wide variety of vendor-specific field analytical technologies for the demonstration and evaluation for use in the cleanup of Superfund Sites. Through the SITE Monitoring and Measurements program, the EPA National Environmental Research Laboratory - Las Vegas has produced several Innovative Technology Evaluation Reports/Profiles to document the results of field analytical technologies it has demonstrated.

H.7.4 The following websites provide information on the application of a field analytical technology to a particular environmental project. Depth of information varies widely from detailed memorandums to case study worksheets outlining general information on applicability, benefits, limitations, and costs.

- EPA **CLU-IN** (**CL**ean-**U**p **IN**formation)
  http://www.clu-in.org/
  This website provides information about innovative technologies for treatment, characterization, and monitoring of hazardous waste remediation projects. Several direct links are provided to key environmental programs and organizations, and others note points of contact or provide files that may be downloaded for access to project reports and memorandums. Numerous publications on the application of field analytical technologies to remediation projects are available for downloading. A few are highlighted below:

- Field Analytical and Site Characterization Technologies - Summary of Applications (EPA-542-R-97-011), November 1997.

- A Guideline for Dynamic Workplans and Field Analytics: The Keys to Cost-Effective Site Characterization and Cleanup (case study).

- Consortium for Site Characterization Technology Fact Sheet, 1997.

- Geophysical Techniques to Locate DNAPLs: Profiles of Federally Funded Projects, 1998.

- Improving the Cost Effectiveness of Hazardous Waste Site Characterization and Monitoring, 2000.

- Innovative Technology Evaluation Reports (see ETV site also).

- University of Connecticut - Guidelines for Applying Field Screening Methods in Conducting Expedited Site Investigations at Underground Storage Tank Sites in Connecticut, November 30, 1996.

- C Site Characterization and Monitoring Technologies: Bibliography of EPA Information Resources.

- C Uncertainty Management: Expediting Cleanup Through Contingency Planning, 1997.

- C EPA Innovations in Site Characterization - Interim Guide to Preparing Case Studies, EPA-542-B-98-009, October 1998

- DOE **CMST-CP** (**C**haracterization, **M**onitoring and **S**ensor **T**echnology **C**ross Cutting **P**rogram) http://em-52.em.doe.gov/ifd/rbbooks/cmst/cmstrb.htm
  This website provides information on the application of several unique field analytical technologies (PAWS (portable acoustic wave sensor systems), SAWs (surface acoustic wave array detectors), portable GC/MS systems, etc.) that are focused on the characterization of mixed waste and high-level and environmental wastes.

H.7.5 Other sources of information include various Federal, State, local, and private organizations, publications, vendor Web sites, etc. A few examples are given as follows:

- Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), EPA 402-R-97-016 (NUREG-1575), December 1997 (radionuclide field analytical technologies)

- EPA Innovations in Site Characterization - Interim Guide to Preparing Case Studies, EPA-542-B-98-009, October 1998

- EPA Region I, New England - Immunoassay Guidelines for Planning Environmental Projects, October 1996

- CMECC (California Military Environmental Coordination Committee) - Field Analytical Measurement Technologies, Applications, and Selection, April 1996

- ASTM Methods, Draft Standard Guide for Selection of Chemical Field Screening and Field Analytical Methods Used in Vadoze Zone Investigation

- Current Protocols in Field Analytical Chemistry, V. Lopez-Avila, ed., John Wiley & Sons, Inc., New York, 1998.

- Manufacturer/Vendor Information (paper and electronic)